Partial-to-Partial Shape Matching with Geometric Consistency

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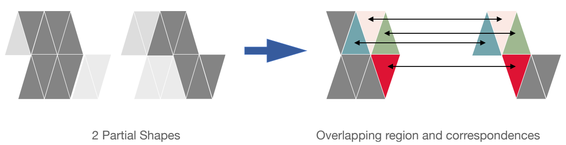
Problem Formulation

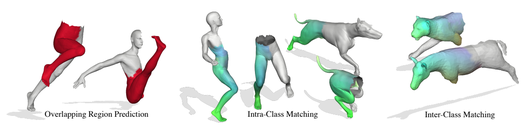
Find correspondences between two partial shapes



Geometric Consistency: **Neighboring triangles** are matched on **neighboring triangles**

Our Contributions

- **Geometrically consistent** non-linear integer programming approach to for **partial-to-partial shape matching** with SOTA deep features
- **Pruned search algorithm**
- **Inter-class** Partial-to-Partial Datasets
- **State-of-the-art performance** regarding geodesic error and Intersection over Union (IoU)



Current State-of-the-Art

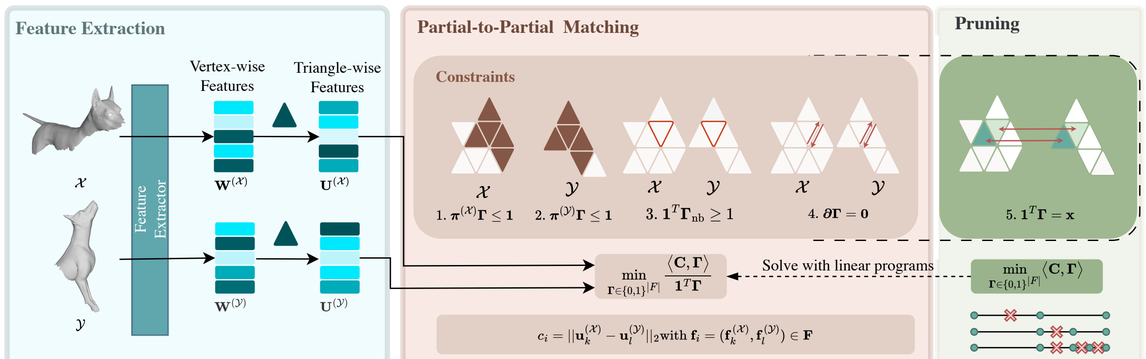
Sm-Comb [1]

- ✓ Geometric Consistency
- ✗ Handle partial shapes (Holes need to be closed)

DPFM [2]

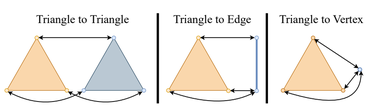
- ✓ SOTA partial-to-partial shape matching
- ✗ Supervision during training required

Method



Definitions

- Product triangles **F**: Possible matchings



- Product space $\Gamma \in \{0,1\}^{|\mathbf{F}|}$: Matching encoding
- Costvector $\mathbf{C} \in \mathbb{R}^{|\mathbf{F}|}$: Matching costs for product triangles based on SOTA partial deep features

Objective

Non-linear objective: Minimize **mean matching cost**

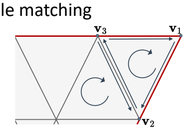
Constraints

1./2. Every triangle is matched at **most once**

3. Minimum one triangle to triangle matching

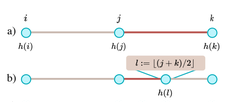
4. Geometric Consistency

(**5.** x elements in Gamma are 1)

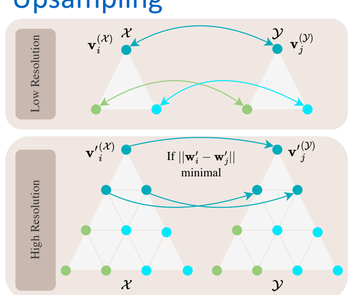


Interval Search

Solve ILPs only for intervals with potentially smaller minimum



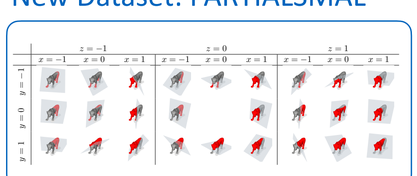
Upsampling



Utilize **nearest neighbor search**:

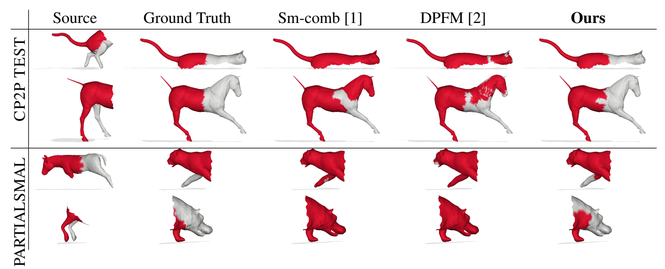
- Consider upsampled vertices (dark blue) between matched vertices $\mathbf{v}_i^{(\mathbf{X})}$ and $\mathbf{v}_j^{(\mathbf{Y})}$
- Choose this vertex $\mathbf{v}_i'^{(\mathbf{Y})}$, that has the smallest distance in feature space of $\mathbf{W}^{(\mathbf{X})}$ and $\mathbf{W}^{(\mathbf{Y})}$

New Dataset: PARTIALSMAL

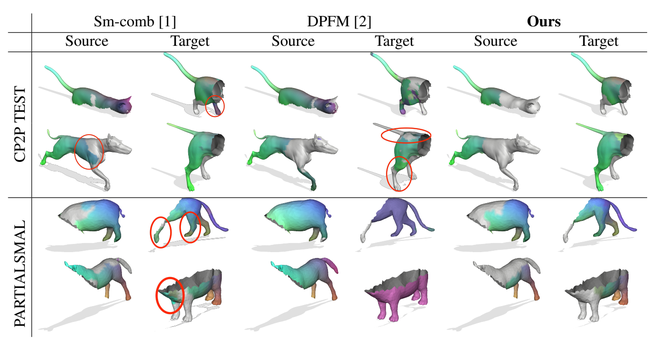


Results

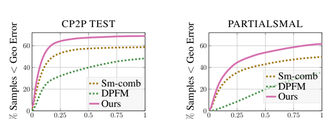
Overlapping Region Prediction



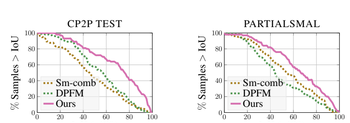
Correspondence Prediction



Geodesic Error



IoU



References:

[1] Paul Roetzer, Paul Swoboda, Daniel Cremers, and Florian Bernard. A scalable combinatorial solver for elastic geometrically consistent 3d shape matching. *CVPR*, 2022

[2] Attaiki, Souhaib, Gautam Pai, and Maks Ovsjanikov. Dpfm: Deep partial functional maps. 3DV, 2021.